# Analysis of the traded volume drivers of the Iberian power futures market

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A B S T R A C T

A comprehensive assessment of the liquidity development in the Iberian power futures market managed by OMIP ("Operador do Mercado Ibérico de Energia, Pólo Português") in its first 4 years of existence is performed. This market started on July 2006. A regression model tracking the evolution of the traded volumes in the continuous market is built as a function of 12 potential liquidity drivers. The only significant drivers are the traded volumes in OMIP compulsory auctions, the traded volumes in the "Over The Counter" (OTC) market, and the OTC cleared volumes in OMIP clearing house (OMIClear). Furthermore, the enrollment of financial members shows strong correlation with the traded volumes in the continuous market. OMIP liquidity is still far from the levels reached by the most mature European markets (Nord Pool and EEX). The market operator and its clearing house could develop efficient marketing actions to attract new entrants active in the spot market (energy intensive industries, suppliers, and small producers) as well as volumes from the opaque OTC market, and to improve the performance of existing illiquid products. An active dialogue with all the stakeholders (market participants, spot market operator, and supervisory authorities) will help to implement such actions.

*Keywords:*
Electricity sector
Power futures market
Liquidity
Energy regulation
Market supervision

## 1. Introduction

Since its beginning on July 3, 2006, the Iberian power futures market managed by OMIP, within the framework of the Iberian Electricity Market ("MIBEL"), has experienced a continuous development, in terms of number of participants, number of trades, traded volumes, aggregated open interest and smaller bid-ask spreads. At the end of June 2010, 39 market players participated in OMIP. Nineteen of them belong to Iberian vertically integrated energy groups. The most populated group, if excluded the vertically integrated energy companies, is composed of 11 energy traders. Only nine members are pure financial agents, still a reduced figure [1]. The main amount of traded energy in OMIP has been driven by *compulsory call auctions* according to national regulations aimed at employing such auctions as a transient mechanism to foster the liquidity of the continuous market managed by OMIP. The five largest Spanish distribution companies have been obliged to purchase in these auctions until July 2009, in order to partly cover their portfolios of end-user regulated supplies. Likewise, the Portuguese last resort supplier kept that obligation until July 2010. Description of the main features of the MIBEL derivatives market during its first 2 years of existence can be found in [2]. That research focused on the analysis of the price efficiency by means of the *ex-post forward risk premium*. Furió and Meneu [3] define the premium as the difference between the average settlement price of a futures contract and the resulting average spot price during delivery. Energy markets show limited levels of market efficiency and the behaviour of OMIP futures prices does not differ much in terms of price efficiency compared to the most mature European power derivatives markets [2].

The current research analyzes the efficiency of the Iberian power futures market focused on another cornerstone: liquidity. The employed data set is robust, as it covers the first 4 years of existence of this market (from July 3, 2006, to June 30, 2010). Such an ample data set facilitates the detection of the most significant traded volume drivers and on the other hand, the identification of the products that still show poor performance (i.e. illiquidity). These findings allow the formulation of policy recommendations for streamlining the efficiency of this market. A regression model using Ordinary Least Square methodology is estimated to assess the effect of 12 selected drivers (the independent variables) for the following key liquidity measure (the dependent variable): the evolution of the energy traded in the continuous market. The research is also reinforced by means of a correlation analysis of the independent variables with the dependent variable. As market players trade essentially energy derivatives to hedge their supply commitments [4] – in the case of electricity suppliers, such hedges through forward contracting are established to secure their retailing margin [5] – the analysis of the traded volume drivers allows to determine if the Iberian power futures market is growing properly to consolidate its original role as key hedging vehicle. Other typical liquidity measures, suggesting potential research for further

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analysis of this relatively young market, are the bid-ask spreads [6], the open interest [7], the volatility and sensitivity of prices to additional demand [8], and the resilience [9]. The term resilience, whose original use comes from Physics, is widely used in other scientific areas, as Finance – related to the robustness of the financial institutions or even the whole financial system [10]. In the case of liquid energy markets, prices must be resilient to large orders [9]. In the Iberian power futures market, the resilience is mainly secured by the market regulation, as the market operator establishes maximum price variation limits. The orders exceeding such limits cannot be matched [11]. Additionally, The Spanish Energy Commission (*Comisión Nacional de Energía*, CNE) performs weekly monitoring of the evolution of the power futures prices and the OTC prices, by means of charts of OMIP settlement prices and OTC weighted average prices [12]. As deviations between the values of both price series are not usual, the resilience is also found in the OTC market, strengthening the forward market integrity.

The article is structured as follows: (i) Section 2 performs a literature review of relevant studies regarding liquidity of energy markets; (ii) Section 3 provides a comprehensive overview of the Iberian power futures market, including a basic description of the coexistent regulated forward contracting mechanisms, and comparison with the liquidity levels of the Spanish OTC market and with the most mature European power futures markets; (iii) Section 4 performs a thorough analysis of the traded volume drivers in OMIP continuous market by means of a regression model and correlation analysis; (iv) Section 5 formulates recommendations for the proper development of this market; (v) Section 6 concludes summarizing the main findings and suggesting further research.

## 2. Literature review of liquidity in energy markets

### 2.1. Academic research

Fusaro [13] researches about the emerging energy derivatives markets since the 1980s (oil and gas) and 1990s (power) describing their specificities compared to the original pure financial markets. He defines liquidity as a characteristic of a market where there is a high level of trading activity. He provides an overview of the development of North American, European and Asian oil, gas, and power markets. He foresees the liquidity growth in those markets due to the development of energy derivatives. Mork [14] researches about the deregulated European power markets in the 1990s envisaging the emergence of financial markets for electricity. He focuses in three case studies: United Kingdom, Norway and Switzerland. He indicates that the Nordic region has developed a quite advanced and well-functioning electricity trading pool, with widespread financial trading and good liquidity. In order to create healthy financial power markets, the choice of pool model, including spot, adjustment and forward markets, will make or break liquidity. Newbery et al. [9] analyze the inadequate liquidity level of the Dutch electricity market. They indicate that liquid markets enable the immediate execution of standard orders, exhibit prices that are resilient to large orders, and present low transaction costs due to the high amount of active participants and traded volumes. Based on this analysis and on the Monitoring Report on the Dutch Wholesale Electricity Market, 2006, prepared by the Office of Energy Regulation (DTe) for the Netherlands Competition Authority (NMa), Krishna [8] examines the existing measures of liquidity in that market adopted by NMa. He defines liquidity as the ability of an asset to be instantly converted into cash without any significant movement in the price. He detects the liquidity improvement caused by the decline of the level of bid-ask spreads in the period 2006–2007. He also detects a positive, though insignificant relationship between the volatility of electricity prices and the level of liquidity in the Dutch electricity markets in that period. Hence, the volatility in prices in this electricity market during this period is not necessarily a sign of illiquidity. Batlle et al. [15] indicate the positive effects of the *market maker agreements* for enhancing liquidity. Their research, applied to the French balancing power market, proposes to introduce such agreements in order to improve efficiency. Market makers are needed when the structure of the traders is such that liquidity does not arise naturally. A market maker is an exchange member obliged to make a continuous two-way price, creating bid and ask prices for a given security. It generally maintains inventory and stands ready to buy and sell at the quoted price to keep a functioning market and fostering liquidity. Due to such a dynamic and active quotation service, they constitute a key factor in attracting new actors in the organized markets [16]. Otherwise, the new actors should be mainly obliged to contract OTC brokerage services to find counterparty, or establish bilateral contracts. Meeus [17] analyzes the regulation of the European power exchanges, distinguishing between "merchant" and "cost-of-service-regulated". He indicates that the exchanges can benefit from a positive network externality, as liquidity attracts liquidity. The liquidity supporting measures fostered by regulators, forcing international traders, Transport System Operators, or incumbent generation companies to trade on the incumbent power exchange, improve the liquidity of that exchange. However, due to the natural monopoly features of the exchanges, they reinforce the dominant position of the incumbent power exchange, which can be problematic. Molzahn and Singletary [18], in their research about the Financial Transmission Rights (FTRs) in the North American Midwest Independent System Operator (MISO) auction market, indicate that the large speculator profits are potentially concerning. On the other hand, they find support to the argument that speculators confer useful liquidity benefits. Regarding liquidity of emission trading programs and international emission markets, an overview can be found in [19]. For the case of Tradable White Certificates (TWCs), Mundaca [20] describes the liquidity increase due to the implementation of a European scheme to improve energy efficiency.

### 2.2. Supervision reports in European energy markets

#### 2.2.1. Monitoring of market liquidity by the European Commission

The Directorate-General for Energy (DG ENER) of the European Commission performed in year 2008 – at that time named DG TREN, as it also covered transport issues – two analyses of EU wholesale energy markets. The first one [21] evaluates the factors impacting on current and future market liquidity and efficiency. EU wholesale energy markets were relatively underdeveloped. Wholesale power markets were significantly more advanced than natural gas ones. Progress was not uniform and there were large variations in market liquidity and efficiency across the EU. Natural gas, power and $CO_2$ trading is a deregulated activity with a large and growing proportion taking place in the opaque OTC market. Exchange prices set a benchmark for spot prices. OTC is seen as more flexible, cheaper, and offering more specialized products. There is a strong inverse relationship between the levels of *market concentration* and the degree of liquidity. Improvement in supply and demand data *transparency* is a quick-win. The second report [22] analyzes the historical data of EU wholesale electricity, natural gas and $CO_2$ markets. For power exchanges during 2002–2007, a clear increase is found in traded volumes, market participants, and price correlations. There is a negative relation between an increase in market participants and *volatility*. Price volatility remains notably high on spot power trading. Derivative contracts are higher in volume, less volatile but more concentrated on one exchange (the German based European Energy Exchange, EEX). The substantial OTC growth (traded volumes doubling since year 2006) is caused by

trading in *forward physical markets* (1% of total volumes for pure financial trades). Growth of physical connection capacities and *market coupling* initiatives have improved liquidity and price signals.

*2.2.2. OFGEM monitoring of the liquidity of British energy markets*

The British regulatory agency for electricity and gas markets (OFGEM) is analyzing since 2009 the liquidity of the British wholesale power and gas markets. The liquidity (especially in the electricity market) was of concern [23]. The low liquidity acts as a barrier to new entry into generation and supply markets and may be a source of competitive disadvantage to small suppliers. Liquid markets provide investment signals to market participants and reduce *price manipulation*. The low liquidity is a function of *interrelated factors*: the period of rapid growth in vertical integration, which followed the collapse of Enron in 2001–2002 and the exit of active market participants; the regulatory risk; the undermined confidence in market competitiveness; the complex balancing market arrangements, acting as an entry barrier for smaller parties and non-physical participants; the price volatility; the volumes migrated towards the more liquid gas market; the lack of power *exchange based trading*; and the harder credit arrangements and collateral requirements after Enron collapse and in the current financial crisis. OFGEM [24] provides a further consultation of policy options, some of them to be implemented in case current market initiatives fostered by power exchanges and brokers do not get liquidity gains. The options aims to increase the trading of the large vertically integrated utilities by applying self-supply restrictions, obliging them to trade with small/independent suppliers, compelling them to act as market makers, and establishing mandatory sales auctions.

*2.2.3. Analysis of the Nordic derivatives market by the Swedish Energy Authority*

The Swedish Energy Authority conducted in [6] an extensive research of the Nordic Electricity Derivatives Market in order to see how to improve its efficiency. Analysis of the liquidity evolution of the Nordic power exchange (Nord Pool) was done, detecting that the entry and further exit of Enron and other American players clearly affected its liquidity. The financial players reckon 1/3 of the amount of members and traded volume, and they are the group experiencing bigger enrollment in the last years. The distribution companies are the most active players, followed by financial agents. Two further types of agents are distinguished, though less active: the *big four* producers and small producers. The *contract for differences* (CfDs) are very illiquid contracts, showing larger bid-ask spreads. Many agents would desire bigger transparency for OTC trades not cleared through Nord Pool. Comparison with other energy derivatives exchanges confirms that liquidity is poor for contracts whose maturity date is far.

## 3. A comprehensive overview of the evolution of the Iberian power futures market

*3.1. OMIP call auctions, continuous market, and OTC trades settled by OMIClear*

The compulsory call auctions for the Spanish distribution companies ended in June 2009, as since July 2009, their supplies are taken over by the Spanish last resort suppliers. Complementarily OMIP provides the *continuous* trading mode and the possibility to clear OTC trades in OMIP clearing house (OMIClear). Whereas the auction provides a single equilibrium price, the continuous mode matches individual bids and offers. OMIP sessions are composed of four sequential phases: *pre-trade*, *auction*, *continuous trading* and *pre-close*. The *continuous trading* phase has experienced three expansions to foster liquidity – on January 2, 2008; July 1, 2008; and December 15, 2008 – currently ranging from 9:10 am to 4:30 pm. The pre-close phase was expanded in July 1, 2008, closing at 6:30 pm and facilitating a bigger registration of OTC trades [1].

*3.2. The derivatives listed in OMIP*

Table 1 lists the contract types (*futures*, *forwards* and *swaps*) traded in OMIP and/or cleared by OMIClear in the first 4 years of this market. The liquidity level is indicated, according to their traded volumes. Their nominal is 1 MW per delivery hour. They have *financial settlement* and some of them *physical delivery* through the spot market managed by OMEL. The spot reference price used in the settlement is the daily arithmetical mean of the OMEL day ahead price in the Spanish ("SPEL") or Portuguese ("PTEL") zone. The maturities of the contracts are Week ("W"), Month ("M"), Quarter ("Q") and Year ("Y"). Whereas *baseload* refers to each hour of the delivery period, *peak* only embraces 12 h between 8 am and 8 pm from Monday to Friday. The call auctions with peak futures during January 2010–July 2010 were only compulsory for the Portuguese last resort supplier [1].

*3.3. OMIP market makers as liquidity boosters*

OMIP can establish a *market maker agreement* with a trading member, according to *OMIP Instruction 01/2007, Market Makers*, in force since September 1, 2007. Such an agreement specifies the particular conditions for the derivative the market maker is obliged to quote during the validity period. The quoted offers are to be kept at least during an agreed period within the continuous trading phase in each session. Those offers cannot spread more than a given amount of *ticks* (each tick equals 0.01 €/MWh), and should cover at least a minimum agreed amount of contracts. If the market maker has privileged information (*insider trading*), it cannot quote until such information becomes public. It obtains *discounts* in trading and clearing fees regarding traded volumes in the continuous market, as well as *monthly compensations* from OMIP for each contract under its scope [25]. Table 2 summarizes the agreements celebrated during the first 4 years of the market. "M + 1" stands for the prompt month, "Q + 2" for the second prompt quarter, etc.

*3.4. The MIBEL regulated forward contracting mechanisms*

The evolution of the Iberian power futures market cannot be understood without taking into account its coexistence with regulated forward contracting mechanisms, in force since June 2007. Those mechanisms are the *Virtual Power Plant* ("VPP") auctions and the *Contracts of Energy for the Last Resort Supply* auctions ("CESUR", in Spanish, "*Contratos de Energía para el Suministro de Último Recurso*"). Both mechanisms enlarge the forward trading capabilities of the market players, being limited until that moment to the OTC market and the futures market. The Spanish VPP auctions are known as "*Emisiones Primarias de Energía*" (EPE). Call options regarding "virtual" capacity of the Spanish incumbent power companies (Endesa and Iberdrola) are auctioned following a multi-round ascending clock algorithm [26]. The main goal of EPE auctions is to promote forward contracting [27]. The first five EPE auctions involved *physical delivery*, but the sixth and seventh auctions employed *cash-settlement*, facilitating the entry of financial agents. Four VPP auctions have been celebrated in Portugal managed by OMIP and cleared and settled by OMIClear [28,29]. The first two auctions were celebrated by initiative of REN Trading, a subsidiary company of the Portuguese System Operator. The third and fourth auctions were promoted by REN Trading and by EDP Power Generation Management, a subsidiary company of the

**Table 1**
Derivatives listed in OMIP: basic features and liquidity diagnosis. *Source*: [1] adapted by authors.

| Derivative | OMIP | Load | Underlying | Settlement | Market modes | Liquidity level | Available since |
|---|---|---|---|---|---|---|---|
| Futures | FTB | Base | SPEL | Financial, can have physical delivery | Auction continuous OTC registered | Good | July 3, 2006 |
| Forwards swaps | FWB SWB | Base | SPEL | Financial with physical delivery Financial | OTC registered | Null scarce | March 2, 2009 |
| Futures | FPB | Base | PTEL | Financial | Auction continuous OTC registered | Scarce | July 1, 2009 |
| Futures | FTK | Peak | SPEL | Financial, can have physical delivery | Auction continuous OTC registered | Mainly due to compulsory call auctions | January 20, 2010 |

**Table 2**
Market maker agreements within the MIBEL derivatives markets. *Source*: [1] adapted by authors.

| Market maker | FTB contracts | Start date | End date |
|---|---|---|---|
| RBS Sempra | M + 1, M + 2, M + 3<br>M + 1, M + 2 | September 1, 2007<br>May 1, 2008 | March 31, 2008<br>October 31, 2008 |
| EGL Energia Iberia | Q + 1, Q + 2, Y + 1<br>M + 1, M + 2, Q + 1, Q + 2, Y + 1<br>M + 1, M + 2 | November 10, 2008<br>November 12, 2009<br>June, 2010 | November 11, 2009<br>May 31, 2010<br>December 31, 2010 |
| Deutsche Bank | M + 1, M + 2, Y + 1<br>M + 1, M + 2, Q + 1, Q + 2, Y + 1<br>Q + 1, Q + 2, Y + 1 | May 14, 2009<br>November 16, 2009<br>June 1, 2010 | November 13, 2009<br>May 31, 2010<br>December 31, 2010 |
| Citigroup global markets | M + 1, M + 2 | November 2, 2009 | May 31, 2010 |

main Portuguese utility. These auctions released energy traditionally captive to Energy Purchasing Contracts (known in Portuguese as "*CAE*", *Contratos de Aquisição de Energia*) established between the incumbent and certain power plants. CESUR auctions are firstly employed by the Spanish distribution companies and since July 2009 by their related last resort suppliers to cater for part of their regulated supplies. They follow a multi-round descending clock algorithm [30]. These auctions contribute to the price valuation of the energy included in the last resort tariffs. The settlement is pure *financial* since the ninth auction. Table 3 summarizes the main features of all these auctions celebrated during the first 4 years of the Iberian power futures market.

### 3.5. OMIP futures market versus the dominant OTC market

The Iberian *OTC* power market has been developed since 1999 by two brokers [31]. The OTC volumes in the Iberian Market during the first 4 years of the Iberian power futures market have been 4.8

**Table 3**
Regulated forward contracting mechanisms within the MIBEL framework complementing OMIP Call Auctions. *Source*: [12,14,16], adapted by authors.

| | Spanish VPP ("EPE") auction | | | CESUR auction | | | Portuguese VPP auction | |
|---|---|---|---|---|---|---|---|---|
| | Date | Products | | Date | Products | | Date | Products |
| 1st | June 13, 2007 | | 1st | June 19, 2007 | | 1st | June 26, 2007 | Baseload: quarter "Q + 1" |
| 2nd | September 13, 2007 | Baseload and peak: quarter "Q + 1"; 6 month "(Q + 1)+(Q + 2)"; year "(Q + 1)+(Q + 2)+(Q + 3)+(Q + 4)" | 2nd | September 18, 2007 | | 2nd | September 21, 2007 | |
| 3rd | December 11, 2007 | | 3rd | December 18, 2007 | Baseload: quarter "Q + 1" | 3rd | January 16, 2008 | Baseload: months "M + 1", "M + 2"; quarters "Q + 1", "Q + 2", "Q + 3" |
| 4th | March 11, 2008 | | 4th | March 13, 2008 | | 4th | March 7, 2008 | Baseload: quarters "Q + 1", "Q + 2" |
| 5th | June 10, 2008 | | 5th | June 17, 2008 | | | | |
| 6th | September 23, 2008 | Baseload and peak: 6 month "(Q + 1)+(Q + 2)"; year "(Q + 1)+(Q + 2)+(Q + 3)+(Q + 4)" | 6th | September 25, 2008 | Baseload: quarter "Q + 1"; 6 month "(Q + 1)+(Q + 2)" | | | |
| 7th | March 24, 2009 | | 7th | December 16, 2008 | | | | |
| | | | 8th | March 26, 2009 | Baseload and peak: quarter "Q + 1" | | | |
| | | | 9th | June 25, 2009 | | | | |
| | | | 10th | December 15, 2009 | Baseload and peak: quarter "Q + 1"; quarter "Q + 2" | | | |
| | | | 11th | June 23, 2010 | Baseload and peak: quarter "Q + 1" | | | |

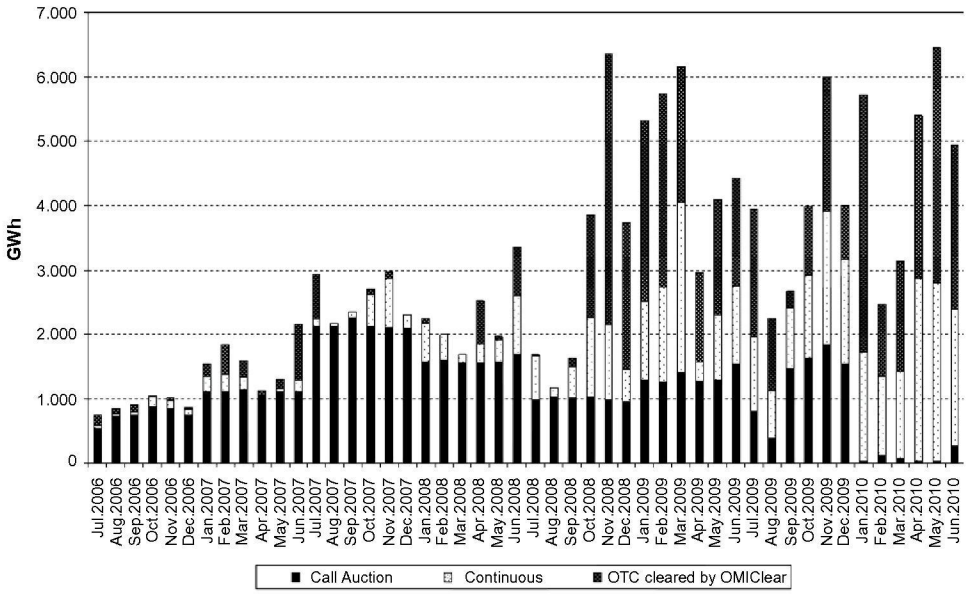


**Fig. 1.** Evolution of trading volumes (GWh) in OMIP (call auctions, continuous and OTC cleared). *Source*: [1] adapted by authors.

times bigger than the volumes exchanged in OMIP (*auctions* and *continuous*) [32]. A percentage of 11% of such OTC volume has been registered by OMIP and settled by OMIClear [1]. As shown in Fig. 1, since the last quarter of 2007 the amount of energy traded in OMIP continuous market tends to grow compared with previous trading levels, with a record in April 2010 (2.8 TWh, a remarkable amount compared to the call auction record (2.3 TWh) in September 2007). The accumulated amount of energy traded in OMIP call auctions is 1.5 times bigger than in the continuous market (5.8 if considering only the first 2 years). The biggest auction volumes were traded in the period July 2007–June 2008.

The volumes negotiated in OMIP continuous market tend to grow remarkably each 6 months, therefore being the continuous trading independent of the variations in the compulsory call auction volumes. The OTC volumes cleared in OMIP reach record levels in November 2008 (4.2 TWh), mainly due to transitorily constrained conditions in the credit markets, favouring the use of clearing houses.

### *3.6. Comparison with the most mature European power futures markets*

Regarding the amount of members and traded volumes, although holding a steady growing pace, OMIP liquidity is still quite reduced compared to other more mature European power futures markets, as Nord Pool (Nordic Countries), EEX (Germany) and Powernext (France). Table 4 compares those markets for year 2008 – prior to the merge of EEX and Powernext in September 2009 [33] – with data obtained from the market operators ([1,34–36]), the British Regulator [23], and the Spanish System Operator [37]. OMIP is close to the figures provided by its neighbour Powernext, but far from the more developed EEX and the outstanding Nord Pool. The *churn* is defined as the ratio of traded volume of a commodity to throughput or generated output, or some other measure denoting physical consumption [23]. It is calculated here as the ratio between the total cleared volumes in the derivatives exchange during year 2008 and the demand for that year. In the case of OMIP, the demand is the Spanish one at busbar, and for Nord Pool, it refers to the aggregation from all the Nordic countries.

## 4. Analysis of the drivers developing the continuous market managed by OMIP

### *4.1. Evolution of the traded volumes in the continuous market*

The evolution of the traded volumes (GWh) in OMIP continuous market can be tracked in Fig. 1. The quarter with biggest trading activity in OMIP continuous market has been the second quarter of year 2010. Bigger volumes of year contracts since the autumn of year 2008 are due to bigger registration of OTC trades cleared by OMIClear, as the OTC market is the favourite mechanism for negotiating large contracts. The gradual increase of the cleared volumes in OMIP is due to bigger trading of quarter and year contracts, motivated by the negotiation of similar contracts in the coexisting auction mechanisms – mainly CESUR auctions – and the OTC market.

### *4.2. The enrollment of trading members*

The increasing enrollment of trading members can be observed in Fig. 2. This chart shows the registered members at the beginning (July 3, 2006) and at the end of each month. Four categories are

**Table 4**
Comparison of the main European power derivatives exchanges with data of year 2008. *Source*: [1,6,20–23], adapted by authors.

| Market | Number of members | Power futures volumes (TWh) | OTC cleared in exchange (TWh) | Total cleared in exchange (TWh) | Demand 2008 (TWh) | Churn: total cleared/ demand |
|---|---|---|---|---|---|---|
| EEX | 118 | 266 | 899 | 1165 | 540 | 2.16 |
| Nord pool | 391 | 1437 | 1140 | 2577 | 426 | 6.05 |
| OMIP | 30 | 22 | 9 | 32 | 264 | 0.12 |
| Powernext | 43 | 87 | 4 | 91 | 503 | 0.18 |

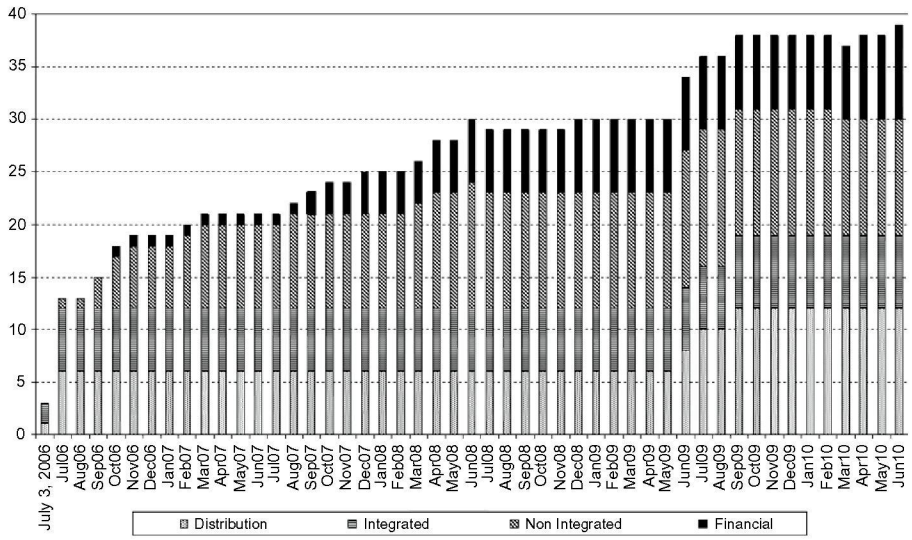


**Fig. 2.** Enrollment of OMIP trading members. *Source*: [1] adapted by authors.

employed: "*Distribution*" refers to Spanish distribution companies and their related last resort suppliers, as well as the Portuguese last resort supplier; "*Integrated*" refers to generation and trading companies belonging to the Iberian vertically integrated energy groups; "*Non Integrated*" refers to energy traders not belonging to Iberian vertically integrated energy groups; "*Financial*" refers to pure financial agents as the commodities branches of investment banks or even brokers.

The first entities entering the market are the consolidated market players in the Iberian energy market, i.e. the Spanish distribution companies and the Portuguese last resort supplier, as well as their affiliated power generation and trading companies. The international energy traders mainly join prior to the first regulated auctions shown in Table 3. The financial entities entered later, with a bigger participation since the end of year 2007, as profitable opportunities might arise in power markets compared to spoilt financial and credit markets. During June 2009–September 2009, the Spanish last resort suppliers enrolled. All the trading members are specialized agents with previous experience in the Spanish spot electricity market or in other European energy markets. There is much room for new enrollments of energy traders and financial players active in the spot market. Nonetheless, in order to get a balanced market structure as in Nord Pool [6] – contributing to increase the price efficiency – the market operator and its clearing house should strive to attract large industrial consumers, suppliers and small producers active in the spot market, hedging their exposure to the spot price volatility.

### 4.3. The discounts in OMIP trading fees

Special discounts in trading fees for strengthening the continuous market began to be applied in the last quarter of 2007 [38]. Further campaigns were applied respectively in the first half of 2008, during the third quarter of 2009, and during 6 months since October 15, 2009 [39–41].

### 4.4. The regression model for the traded volumes in the continuous market

Eq. (1) shows the regression model composed of 12 variables (constant $a_0$ is included) theoretically explaining, according to the main features of the market described in Section 3, the monthly evolution of the traded volumes in the continuous market ($GWh\_Cont_t$).

$$\begin{aligned} GWh\_Cont_t = {} & a_0 + a_1 * Nr\_Integr_t + a_2 * Nr\_Non\_Integr_t + a_3 \\ & * Nr\_Financ_t + a_4 * GWh\_auct_t + a_5 * GWh\_OTC_t \\ & + a_6 * GWh\_OTC\_cl_t + a_7 * Nr\_trading\_sessions_t \\ & + a_8 * Abs(FM_{t+2,t} - S_t) + a_9 * Expans\_Cont_t \\ & + a_{10} * Mkt\_Makers_t + a_{11} * VPP\_CESUR_t + a_{12} \\ & * Cont\_Comiss\_Disc_t + \varepsilon_t \end{aligned} \quad (1)$$

#### 4.4.1. The model description

The 12 variables were selected by means of multicollinearity tests. Error term is expressed through $\varepsilon_t$. The variables are: $Nr\_Integr_t$, $Nr\_Non\_Integr_t$, and $Nr\_Financ_t$ showing respectively the increasing number of integrated, non-integrated, and financial trading members enrolled as depicted in Fig. 2 – a bigger amount of participants should contribute to increase the trading activity; $GWh\_auct_t$, $GWh\_OTC_t$, and $GWh\_OTC\_cl_t$ showing respectively the traded volumes in OMIP auctions, in the OTC market, and the cleared OTC volumes by OMIClear – the exchange liquidity channels (diverse trading modes and the possibility to clear external trades) should attract liquidity [17]; $Nr\_trading\_sessions_t$ indicates the number of OMIP sessions per month, as months with more trading sessions should experience a more sustained trading activity; $FM_{t+2,t} - S_t$ is a *forward risk premium* measuring in absolute value, for each month $t$, the difference between the arithmetical average of OMIP settlement prices for the monthly SPEL baseload futures with delivery 2 months later ($FM_{t+2,t}$) and the average underlying spot price during that month $t$ ($S_t$) – shall the premium be significant, the agents could exploit price arbitrages close to the expiration of the contract, increasing the traded volumes in the continuous market; $Expans\_Cont_t$, $Mkt\_Makers_t$, $VPP\_CESUR_t$, $Cont\_Comiss\_Disc_t$ are dummy variables recording respectively the expansion of the continuous trading phase ("0" until December 2007, "1" since January 2008 onwards) – longer trading periods should contribute to larger trading activity – the existence of market maker agreements (according to Table 2, "1" for the months with agreements in force, "0" otherwise) – the active quotation of the market makers should facilitate the matching of orders – the celebration of regulated auctions (according to Table 3, "1" for the months with celebration of such auctions, "0" otherwise) –

**Table 5**
Regression model results of traded energy in OMIP continuous market. *Source*: Authors.

| Regression model results of traded energy in continuous market | | | |
|---|---|---|---|
| $a_0$ | 2,498.10 | $t_0$ | −1.51 |
| $a_1$ | 190.89 | $t_1$ | 0.91 |
| $a_2$ | −44.28 | $t_2$ | −1.15 |
| $a_3$ | 90.20 | $t_3$ | 1.13 |
| $a_4$ | 0.24 | $t_4$ | 2.07 |
| $a_5$ | 0.05 | $t_5$ | 3.43 |
| $a_6$ | 0.22 | $t_6$ | 3.53 |
| $a_7$ | 47.58 | $t_7$ | 1.30 |
| $a_8$ | 25.08 | $t_8$ | 1.69 |
| $a_9$ | −67.49 | $t_9$ | −0.26 |
| $a_{10}$ | 58.16 | $t_{10}$ | 0.25 |
| $a_{11}$ | 114.36 | $t_{11}$ | 0.96 |
| $a_{12}$ | −94.58 | $t_{12}$ | −0.65 |
| $R^2$ | 0.88 | $t$ | 2.03 |

the arbitrage opportunities with those auctions should facilitate the trading in the continuous market – and the existence of discount campaigns ("1" for the months with campaigns, "0" otherwise) – as previously mentioned, such campaigns intended to foster the trading activity. Good compliance should render positive values for coefficients $a_1$–$a_{12}$ with significant values for their $t$-statistics, as well as high value of $R$-squared statistic. For the $t$-Student test, a level of confidence of 95% with two tails is considered. The number of observations is 48 (monthly values during 4 years).

#### 4.4.2. The regression results

As shown in Table 5, the model renders high $R$-squared statistic (0.88) and the following findings: the only significant variables ($t$ values bigger than 2.03), all with positive coefficients as predicted, are the *OTC cleared volumes* in the futures market, the *OTC volumes* themselves, and OMIP *call auction volumes*. The rest of actions directly performed by the market operator to develop the market – i.e. expansion of the continuous trading phase, creation of market making agreements, and discounts in the variable fees related to trading in the continuous market – do not present significant values (even only the market maker agreements present a positive coefficient, with $t$-value 0.25). Therefore, no linear relation was found between the rest of actions directly performed by the market operator to develop the market, and the traded volumes in the continuous market.

### 4.5. Correlation analysis

The correlation of each variable introduced in the regression model expressed in Eq. (1) with the evolution of the monthly traded volumes in the continuous market is analyzed. The only remarkable correlation coefficients are found for the OTC volumes (0.89), the OTC cleared volumes by OMIClear (0.76) – both parameters were already identified as significant in the regression analysis – and the enrollment of financial agents (0.77). Therefore, marketing incentives to attract these players could increase the trading activity in the continuous market.

## 5. Efficiency recommendations

This section synthesizes all the research findings. They allow to formulate policy recommendations and supervision actions for the Iberian power futures market operator and its clearing house in order to improve their performance and yield liquidity gains.

### 5.1. The three-layers liquidity pyramid

Fig. 3 shows a pyramid in which the diverse liquidity factors are placed according to their theoretical contribution to liquidity improvements. Three layers are distinguished. A bottom–up approach is used, showing the most valuable factors at the top. The highest a power exchange can be located in the pyramid, the largest its efficiency. Therefore, this chart can be used as a graphical efficiency benchmark tool. The youngest and most illiquid power exchanges would be located around the basic layer. Their liquidity growth would mainly be of a quantitative nature (traded volumes, number of agents, etc.). The most mature and liquid power exchanges would be around the top layer, showing qualitative liquidity improvements (e.g. common use of more sophisticated derivatives). The regression model identified only some of the trading drivers as significantly contributing to the traded volume development of the continuous market. The market operator and its clearing house should continuously monitor all these factors through quantitative and qualitative analyses to reach the desired liquidity goals. It would be worthy that the results of such analyses are shared with the supervisory agencies – in this case, represented by the MIBEL Regulatory Council, composed of the Spanish and Portuguese energy and securitires regulatory bodies: CNE, ERSE (*Entidade Reguladora dos Serviços Energéticos*), CNMV (*Comisión Nacional del Mercado de Valores*) and CMVM (*Comissão do Mercado de Valores Mobiliários*). Such agencies could provide feedback and monitor better all the interrelated MIBEL forward markets.

#### 5.1.1. The basic layer

The *basic layer* is composed of the ground drivers. Liquidity develops when a critical mass of trading members and products exist. Coexistence with OTC market and with regulated forward contracting mechanisms should be positive, offering such markets attractive and complementary trading possibilities for market agents. The possibility of price arbitrages – stimulating the trading activity – between all the existing mechanisms was considered in the regression model. *Marketing campaigns* would be desirable to attract market makers and to increase trading volumes, for instance, through commission discounts. Efficient market maker agreements, requesting permanent performance measurement, could diminish bid-ask spreads and contribute to the accurate formation of the reference prices, the so-called *settlement prices* [6,15]. Robust operation of the exchange and the clearing house are of utmost importance. OMIP and OMIClear have so far performed well with no major incidences. The clearing house will get a fundamental role in the development of this market, as in line with the conclusions of the *G20 summit* on September 25, 2009, in Pittsburgh (USA), and the envisaged *policy actions* for the proper regulation of derivatives markets by the *European Commission*, it is expected to increasingly clear the standardized OTC derivative contracts through central clearing houses to mitigate counterparty risk [42]. *Pre-* and *post-trade transparency* are key to ensure fair and orderly trading [21] and [43]. OMIP transparency compares well with European benchmarks (EEX and Nord Pool) regarding public data availability, but improvements should be done in providing timely and more analytical market monitoring reports as the other exchanges usually do. Stakeholders' communication through *steady dialogue* is key to innovate in the right way, responding to real agents' needs, and to properly measure the market development, through the proposed win–win feedback from supervisory agencies. OMIP and OMIClear meet regularly with their members through the *Trading & Products and Clearing & Settlement Committees*' Meeting in order to improve members' satisfaction. The 9th meeting was celebrated in Oporto on May 29, 2009 [44].

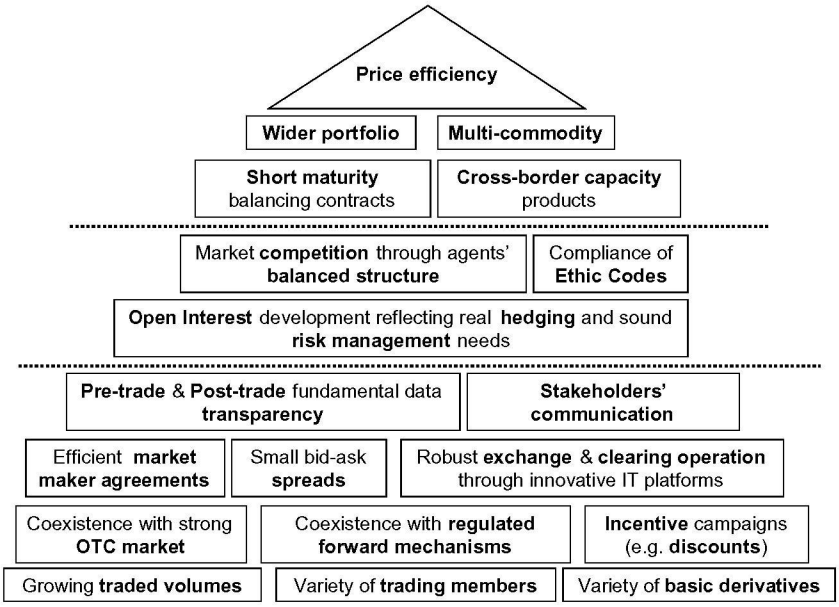


**Fig. 3.** The three-layers liquidity pyramid. *Source*: Authors.

*5.1.2. The intermediate layer*

In the *intermediate layer*, the proper evolution of the open interest related to real hedging practices (i.e. growing evolution of the open interest according to increased cleared volumes in the clearing house), opposed to pure speculative ones is remarked. As indicated by Lucia and Pardo [7], stagnation of the open interest is caused by intra-day trading for strong speculation purposes: the positions are open and close in a single trading session. The analysis of the development of the traded and cleared volumes compared to the evolution of the open interest in OMIP is suggested as further research. A balanced structure of the market according to the desired equilibrated nature of the agents is also pointed out in the pyramid [6]. The traditional classification of market agents as in [31], composed of *hedgers*, *speculators* and *arbitrageurs* is well represented in this market, as shown in Fig. 2. Nonetheless, the reduced amount of trading members in OMIP, in which half of them is related to Iberian incumbents (i.e. vertically integrated companies historically settled in Spain and Portugal), does not help to the proper development of the market (in the case of the United Kingdom, the dominance of the so-called "Big 6" also causes liquidity strains [23]). OMIP should attract other market players active in the mature spot market, especially for intensive energy users and suppliers with strong purchasing hedging needs, as the existing hedgers in the continuous market correspond to a more prone selling nature (generation companies from large vertically integrated utilities). Should new financial agents enter without experience in energy markers, closer oversight should be performed to detect if excessive speculation may arise, increasing the price volatility [4]. Note that the nature of the players in North American commodity derivatives markets has dramatically changed in the last decade, favouring excessive speculation: whereas in 1998, physical hedgers represented 77% of the market, traditional speculators 16% and index speculators 7%, in 2008, physical hedgers were only 31%, while traditional speculators rose to 28% and index speculators to 41% of the total [45]. Small producers, as in [6], would also be welcome to enroll. Some of them could be attracted by improvements in the regulation of distributed generation, as suggested in [46]. According to the international agreement for the constitution of the Iberian Electricity Market, signed in Santiago de Compostela on October 1, 2004, the futures market operator (OMIP) and the spot market operator (OMEL) must exchange stocks and constitute a single Iberian Market Operator (OMI). This monopolistic structure, as those ones described in [17], can generate useful synergies incrementing the efficiency of both markets. For instance, marketing campaigns from OMIP to attract agents active in OMEL (582 producers, 94 suppliers, and four intensive industries, according to [47]) could help to equilibrate OMIP agents' structure, producing liquidity growth and increasing the market competition. OMIP and OMIClear approved their respective *Ethic Codes* in July 6, 2009, amended on May 18, 2010, in order to strengthen their governance structures and supervisory capabilities, promoting and guaranteeing the transparency and competition amongst all the participants. The first meeting was held in Lisbon on July 9, 2009 [40]. Strict compliance of these codes would ensure market integrity and provide liquidity gains.

*5.1.3. The top layer*

In the *top* layer, the development of short maturity products with physical settlement for balancing purposes is suggested. Specific market maker agreements, as in [15], could make such an implementation more effective. Prior to their deployment, OMIP should properly market the still illiquid week contracts, by means of efficient *market maker agreements*, *compulsory call auctions*, and attractive *commission discounts* for those contracts. These actions are also recommended for the *peak* futures, and the baseload PTEL futures shown in Table 1. Good development of the PTEL futures could facilitate cross-border trading in the Spanish-Portuguese interconnection – the introduction of those contracts is justified by the existence of market coupling in MIBEL since July 2007, which has increased the liquidity of the spot market [22] – and would justify the introduction of more *capacity products* (e.g. financial transmission rights, as in [18]), serving as an efficient hedging tool in the Iberian energy market. Liquidity may grow by offering an ampler portfolio of derivatives (e.g. options), other energy related products (e.g. derivatives related to the European Emission Trading Scheme, as described in [48]), and even market mechanisms for establishing a forward price related to the integration of renewable energy sources in the Spanish and Portuguese energy systems. A description of the penetration of the renewable generation in the Iberian Electricity Market can be found in [49]. The summit of the pyramid shows the desired goal of the *price efficiency*, in terms of resilience as defined in [9], convergence with

the OTC market [12], and reasonable evolution (neither inflated nor biased) of the *forward risk premium* related to the spot market as analyzed in [2,3]. For the sake of a bigger amount of futures trades originated by the incumbents instead of their natural trend to establish opaque bilateral trades [24], OMIP-OMIClear could provide trading and/or clearing commission discounts for the incumbents in case they exceed a given threshold of traded and/or cleared volumes. Those thresholds could be defined by the energy regulators (CNE and ERSE). In the case that such incumbents were active participants in the opaque OTC market, this measure would bring, in general, price transparency and, in particular, a potential remarkable liquidity growth in the futures market, both increasing the efficiency of the Iberian forward market. Whereas the most mature European energy derivatives markets (Nord Pool and EEX) can be located within the top layer – the first European exchange in reaching such recognition is Nord Pool [6,14] – OMIP still strives to enter the intermediate layer. The exposed policy actions, expressing efficiency recommendations, would help OMIP-OMIClear to evolve upwards in this illustrative pyramid.

## 6. Conclusions

Since its beginning on July 3, 2006, the Iberian power futures market managed by OMIP has experienced a steady development, in terms of number of participants and traded volumes. Nevertheless, OMIP liquidity is still poor compared to other more mature European power futures markets (Nord Pool and EEX) [1,23,34–37]. Therefore, whereas Nord Pool and EEX can be located at the top of a graphical liquidity pyramid composed of three layers in a bottom–up approach, OMIP still strives to enter the intermediate layer. In this sense, whereas OMIP transparency compares well with those exchanges regarding public data availability, contributing such data transparency to trading confidence and thus liquidity growth [21,43], bigger efforts and resources should be employed by OMIP to provide timely and more analytical market monitoring reports as the other exchanges usually do. A regression model is built to identify the main factors behind the development of one key liquidity measure: the traded volumes in OMIP continuous market. The model is composed of 12 parameters (independent variables) theoretically contributing to the development of the traded volumes in the continuous market (the dependent variable). According to the regression results, the only significant parameters acting as effective liquidity drivers are the traded volumes in the dominant OTC market, the OTC cleared volumes by OMIClear, and the call auctions in which the Spanish distribution companies and the Portuguese last resort supplier are obliged to purchase energy according to national legislation. Additionally, correlation analysis of the 12 variables with the traded volumes in the continuous market also shows a significant correlation of the enrollment of financial agents. Therefore, marketing incentives to attract these players could increase the trading activity in the continuous market. Apart from that potential group of new entrants, there is still much room for new enrollments in OMIP, especially for large industrial users and suppliers active in the spot market and small producers. The enrollment of these companies would create a more balanced structure in the market [6,31]. Apart from increasing the trading activity, it would facilitate a less biased price formation in terms of forward risk premium [2,3]. On the other hand, specific commission discounts for the large vertically integrated groups to trade in OMIP and clear OTC volumes in OMIClear would bring price transparency and liquidity growth [24], in case such vertically integrated utilities were active OTC participants. The market operator could establish specific market maker agreements [15], commission discounts, and auctions complementary to the continuous market to boost the still illiquid products. The market operator and its clearing house should hold a permanent dialogue with all the stakeholders, both with the agents and the spot market operator (as attractive products can only be offered if they respond to real market needs) and with the supervisory agencies (as new developments in market rules should improve the market efficiency). Collaborative efforts between market operator and supervisory agencies create strong synergies: the market operator could invite the supervisory agencies to provide feedback about its analyses measuring the performance of new business developments. Such shared vision would benefit both entities due to the liquidity and efficiency gains. Social welfare would increase as well, positively contributing to a better price formation of end user's electricity prices. Further research is encouraged by analyzing the evolution of other liquidity measures, as the bid-ask spreads [6], the open interest [7], the volatility and sensitivity of prices to additional demand [8], and the resilience [9]. Especially interesting, in a context of high volatility in financial and commodities markets [4], would be the research about the open interest in OMIP futures market: whereas the daily trading volume reflects movements in the speculative activity, the daily open interest captures hedging activities as it excludes intraday positions taken by day traders, mainly inspired by speculative reasons [7]. Additionally, the research can also be enriched by consulting literature regarding similar experiences in North American energy derivatives markets and by analyzing the impact of coming new financial legislation in European and North American markets [42,43].

## References


[1] OMIP-OMIClear. Daily market bulletins of the MIBEL derivatives market, July 3, 2006–June 30, 2010; 2010.
[2] Capitán Herráiz A, Rodríguez Monroy C. Analysis of the efficiency of the Iberian power futures market. Energy Policy 2009;37:3566–79.
[3] Furió D, Meneu V. Expectations and forward risk premium in the Spanish deregulated power market. Energy Policy 2010;38:784–93.
[4] Universia. Everything from oil to silver: are speculators causing too much volatility? Universia Knowledge Wharton, Finance and Investment, Publish Date: June 01, 2011; 2011.
[5] Bartelj L, Paravan D, Gubina AF, Golob R. Valuating risk from sales contract offer maturity in electricity market. Int J Elect Power Energy Syst 2010;32(2):147–55.
[6] STEM. Finansiella elmarknaden. Kapitel 5, Likviditet på nord pool. Statens energimyndighet (STEM), Eskilstuna, Sweden; 2006. p. 32–46.
[7] Lucia J, Pardo Á. On measuring speculative and hedging activities in futures markets from volume and open interest data. Appl Econ 2008:1–9.
[8] Krishna R. Liquidity in the Dutch wholesale electricity markets. MSc economics thesis, Tilburg University; 2008.
[9] Newbery D, von der Fehr NH, van Damme E. Liquidity in the Dutch wholesale electricity market. Den Haag, May 2003; 2003.
[10] González-Páramo JM. Risk, return, resilience. The future financial system. European Central Bank. In: Speech at 3rd annual risk and return Russia conference, Moscow, 14 April 2011; 2011.
[11] OMIP. OMIP notice 04/2006. Price variation limits, version of 20 May 2011; 2011.
[12] CNE. Boletín semanal de futuros y OTC eléctricos. Semana del 18 al 22 de julio de 2011. Dirección de mercados derivados de energía. Comisión Nacional de Energía, Madrid; 2011.
[13] Fusaro PC. Energy risk management. Hedging strategies and instruments for the international energy markets. New York: McGraw-Hill; 2011.
[14] Mork E. Emergence of financial markets for electricity: a European perspective. Energy Policy 2001;29(1):7–15.
[15] Batlle C, Vázquez C, Barquín J. The balancing market maker: a tool to enhance liquidity in the French balancing mechanism. Elect J 2007;20(6):76–86.
[16] Batlle C. Letters to the editor: "balancing market maker" proposal for France poses several key questions. Carlos Batlle's reply. Elect J 2007;20(10):5–6.
[17] Meeus L. Why (and how) to regulate power exchanges in the EU market integration context? Energy Policy 2011;39(3):1470–5.
[18] Molzahn D, Singletary C. An empirical investigation of speculation in the MISO financial transmission rights auction market. Elect J 2011;24(5):57–68.
[19] Haites E, Missfeldt F. Liquidity implications of a commitment period reserve at national and global levels. Energy Econ 2004;26(5):845–68.
[20] Mundaca L. Markets for energy efficiency: exploring the implications of an EU-wide 'tradable white certificate' scheme. Energy Econ 2008;30(6):3016–43.
[21] European Commission DG TREN. Review and analysis of EU wholesale energy markets. Evaluation of factors impacting on current and future market liquidity and efficiency. Research findings and conclusions, 2nd July 2008. Prepared by the Moffatt Associates Partnership, London; 2008.

[22] European Commission DG TREN. Review and analysis of EU wholesale energy markets. Historical and current data analysis of EU wholesale electricity, gas and $CO_2$ markets. Final report, 9 September 2008. Prepared by ECORYS Nederland BV, Rotterdam; 2008.
[23] OFGEM. Liquidity in the GB wholesale energy markets. Discussion Paper, 08 June 2009, Office for Electricity and Gas Markets (OFGEM), London; 2009.
[24] OFGEM. Liquidity proposals for the GB wholesale electricity market. Consultation, 22 February 2010, London; 2010.
[25] OMIP. OMIP instruction 01/2007, market makers, version of 18 November 2008; 2008.
[26] EPE. Official website of Spanish virtual power plant auctions ("EPE", emisiones primarias de energía); 2009. <http://www.subasta-epe.com/es/public>.
[27] CNE. Comisión nacional de energía. Consulta pública sobre las emisiones primarias de energía y su impacto sobre el desarrollo de la contratación a plazo y la competencia. July 16, 2009, Madrid; 2009.
[28] OMIP-OMIClear. Website for information and results of VPP auctions held in Portugal ("Leilões PT-VPP"); 2008. <http://www.omip-sa.com/listas.php?id=176>.
[29] MIBEL Regulatory council. Descripción del funcionamiento del MIBEL, November 2009, by CMVM, ERSE, CNMV, and CNE; 2009.
[30] CESUR. Official websites of Spanish bilateral contracting auctions for last resort supplies ("CESUR auctions"): 1–5th auctions, <http://www.subasta-cesur.eu/auction.asp>; from 6th onwards; 2011. <http://www.subastascesur.omel.es/frames/index.jsp>.
[31] Martín Martínez MJ. Mecanismos de contratación a plazo de energía eléctrica. Energía: desarrollos regulatorios en iberoamérica. ARIAE, 2008, XII reunión anual iberoamericana de reguladores de la energía. Ed. Civitas, Navarra, Spain; 2008. p. 375–91.
[32] Intermoney. El mercado eléctrico en españa, junio 2010. Madrid, 15 de julio de 2010, im energía sa, consultoría; 2010. p. 57.
[33] EEX. Power trading results on EPEX spot and EEX power derivatives in 2009, press release, EPEX spot European power exchange and EEX power derivatives, Leipzig, Paris, 13 January 2010; 2010.
[34] EEX. Growth through security, 2008, annual report, EEX, European energy exchange AG, Leipzig; 2009.
[35] Nord pool. Nord pool ASA, annual report, 2008, Lysaker; 2009.
[36] Powernext. 2008 Market activity. Powernext SA, Paris; 2009.
[37] REE. Red eléctrica de españa, boletín mensual, diciembre 2008, número 24. Fecha de edición: 27/01/09, Madrid; 2009.
[38] OMIP. OMIP news, 4th quarter 2007; 2007.
[39] OMIP. OMIP news, 1st quarter 2008; 2008.
[40] OMIP. OMIP news, 3rd quarter 2009; 2009.
[41] OMIP. OMIP news, 4th quarter 2009; 2009.
[42] European Commission DG MARKT. Brussels, COM(2009) 563/4. Provisional version. Communication from the commission to the European parliament, the council, the European economic and social committee, the committee of the regions and the European central bank. Ensuring efficient, safe and sound derivatives markets: future policy actions; 2009.
[43] European commission DG TREN. Draft discussion paper by DG TREN on transparency and integrity of traded wholesale markets in electricity and gas, 09 December 2009; 2009.
[44] OMIP. OMIP news, 2nd quarter 2009; 2009.
[45] IECA. Industrial energy consumers of America applaud senator lincoln for derivatives reform legislation. News release, April 20, 2010. Industrial Energy Consumers of America (IECA), Washington, DC; 2010.
[46] Frías P, Gómez T, Cossent R, Rivier J. Improvements in current European network regulation to facilitate the integration of distributed generation. Int J Elect Power Energy Syst 2009;31(9):445–51.
[47] OMEL. El mercado de electricidad, octubre de 2010, OMEL; 2010.
[48] Kockar I, Conejo AJ, McDonald JR. Influence of the emissions trading scheme on generation scheduling. Int J Elect Power Energy Syst 2009;31(9):465–73.
[49] Matos M, Lopes JP, Rosa M, Ferreira R, Leite da Silva A, Sales W, et al. Probabilistic evaluation of reserve requirements of generating systems with renewable power sources: the Portuguese and Spanish cases. Int J Elect Power Energy Syst 2009;31(9):465–73.